PARTICULATE MONITORING
AROUND REPAP MANITOBA INC.
THE PAS, MANITOBA

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by

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ABSTRACT

As a result of damage to air emission control equipment at the Repap Manitoba pulp and paper operation in The Pas, the Manitoba Department of Environment, in cooperation with Repap, monitored ambient air for particulate and constituents (sulphate and sodium). Monitoring was conducted from December 20, 1990 to March 27, 1991 at four sites around Repap.

Only twenty-eight percent of the samples were collected when winds could be considered to be from the general direction of Repap.

Total Suspended Particulate (TSP) levels were well below Manitoba Air Quality Objective levels, were lower than at a Winnipeg downtown site, but similar to a Winnipeg residential site and a background rural site.

Sodium (Na) levels were largely undetectable although the highest reading did occur when winds were from the general direction of Repap.

Sulphate (SO_4) levels were higher in The Pas area than those found at any of the Winnipeg area sites during the same period and the highest reading occurred when winds were from the general direction of Repap.

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INTRODUCTION

Monitoring for Total Suspended Particulates and selected constituents associated with the emissions (sodium and sulphate) was undertaken around Repap Manitoba Inc. in The Pas. This was initiated as a result of a fire on November 25,1991 destroying the recovery boiler's electrostatic precipitator which filters particulate from the plant's emissions into the atmosphere.

This project was a joint undertaking between Repap and Manitoba Environment. Monitoring was performed at four locations around the Repap plant on a regular basis from December 20, 1990 to March 27, 1991.

Total Suspended Particulate (TSP) is a general term which applies to a large variety of solid or liquid particles of a size and configuration such that they remain suspended in the air and can be drawn into the respiratory passages. These types of particles , usually in the size range of 0.1 to 100 microns may originate as a result of industrial processes, human activities and from natural sources such as wind swept or entrained dust. By itself, or in association with other pollutants, TSP, in enough concentration, may injure the respiratory system. TSP may also reduce visibility and contribute to property damage and soiling.

The Manitoba Air Quality Objective (MAQO) for TSP has a Maximum Acceptable Level of 120 micrograms per cubic metre ($\mu g/m^3$) of air when measured as a twenty-four hour average. Maximum Acceptable Levels are intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well being.

Sodium sulphate, a mild neutral salt, was expected to be one of the major components of the boiler stack particulate. While sodium in high concentrations can adversely affect soil structure and plant growth, soils in The Pas area are low in sodium and can therefore withstand additional amounts.

Sulphates are not thought to pose a threat to the soil chemistry but they can impact on health as small particles which enter the respiratory system. Also, sulphates have been associated as a major contributing factor to visibility reduction.

There are no specific Manitoba Guidelines or Objectives for sodium or sulphate; the objective for TSP would generally apply. Analysis for sodium and sulphates was primarily undertaken in an attempt to fingerprint the potential impact of emissions on local ambient air particulate concentrations.

PROCEDURE

Total Suspended Particulates and components were collected using the standard high volume sampling method. Air was drawn into a covered housing and through a glass fibre filter (Gelman type A/E) by means of a high flowrate blower at a flowrate of about 1.13 to 1.70 cubic metres per minute for a 24-hour period (calendar day). This allowed suspended particles within the size range of 0.1 to 100 micrometres diameter size to collect on the filter. The mass concentration of suspended particulate in the ambient air was calculated by measuring the mass of collected particles (gravimetrically) and the volume of air sampled.

Sodium and sulphate in the suspended particulate was analyzed and calculated from the total mass of each and the volume of air sampled corrected to reference conditions of 25 degrees Celsius and 101.3 Kilopascals.

The high volume samplers were set up at four locations around Repap largely based on logistical factors, such as access and the availability of power. The sampling sites were selected in an attempt to make measurements in the four major compass directions around the plant (Figure 1). Repap North was the Manitoba Department of Natural Resources storage compound at the airport turnoff from Highway #10; it was NNW of the plant and approximately 11 kilometres away. Repap East was on the south side of the Saskatchewan River on a residential property in the vicinity of Ralls Island; it was ESE of the plant and approximately 4 kilometres away. Repap South was on the roof of a water pumping station on the north bank of the Saskatchewan River; it was SSE of the plant and approximately 2 kilometres away. Repap West was in the town of The Pas, on the roof of the Town Hall; it was SSW of the plant and approximately 4.5 kilometres away.

Sampling was conducted from midnight to midnight for a 24-hour period by use of timing devices.

The high volume samplers were calibrated with an orifice kit prior to the start of the survey and after any repairs to the samplers.

After sample collection, the filters along with blanks were submitted to Manitoba Environment's Technical Services Laboratory for gravimetric particulate loading determination and sodium and sulphate analysis. Sodium was analyzed by Argon Plasma Atomic Absorption and sulphate by Continuous Flow Colourimetric Analysis. Particulate, sodium and sulphate levels were calculated using calibration data and correction of all air volumes to reference conditions of 25 degrees C and 101.3 Kpascals.

Wind speed and wind direction information was obtained from the Atmospheric Environment Service of Environment Canada. Measurements were from The Pas airport located about 15 kilometres NNE of the Repap plant.

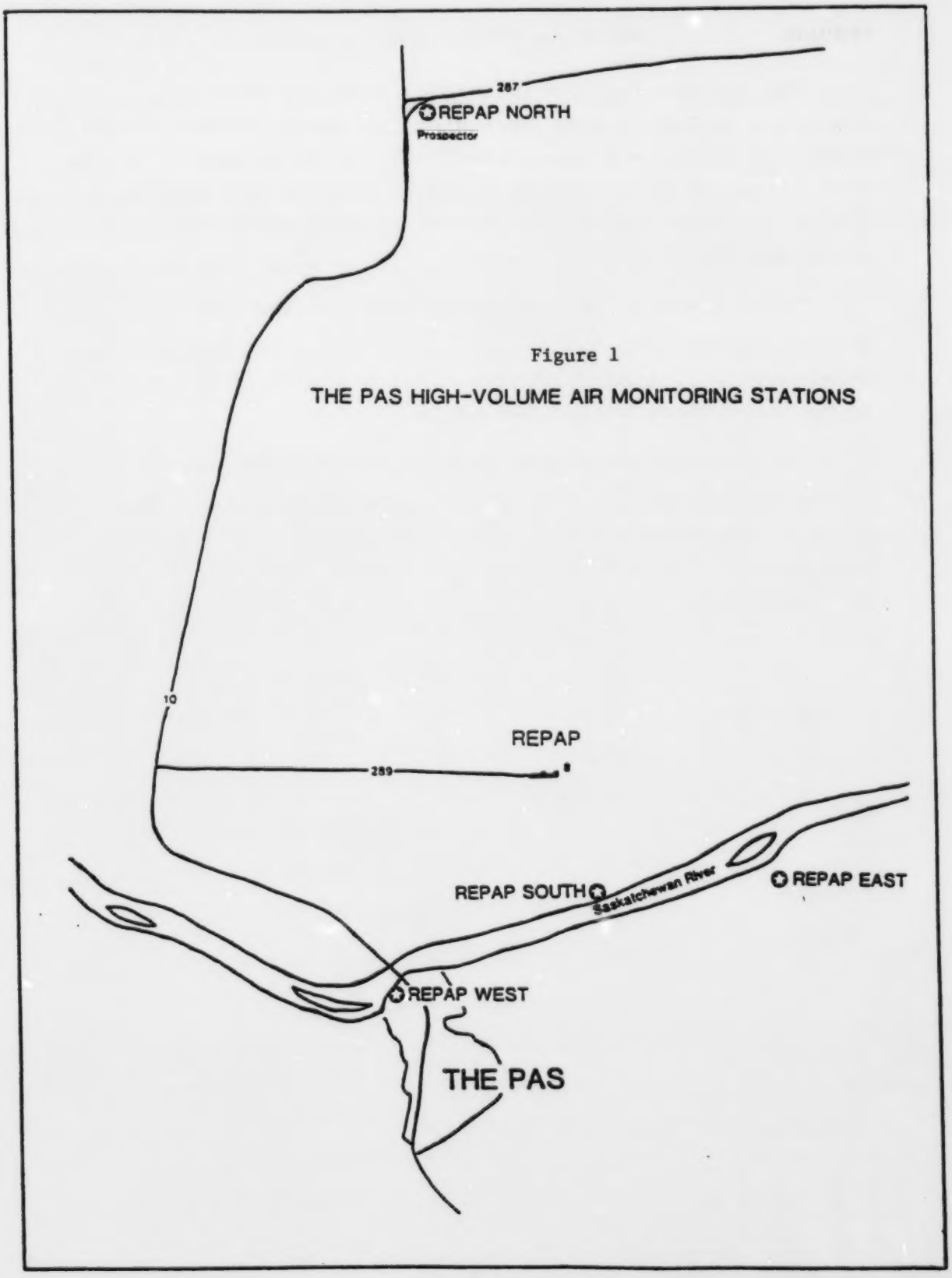

Figure 1

THE PAS HIGH-VOLUME AIR MONITORING STATIONS

RESULTS

The results for the individual sampling days are contained in Tables 1-4, including the daily average wind speed and prevailing wind direction, the relationship of the wind direction to the Repap location and the particulate, sodium and sulphate concentrations in micrograms per cubic metre ($\mu g/m^3$) of air.

Table 5 ranks the ten highest TSP, Na and SO_4 concentrations from highest to lowest and describes their relationship to wind direction. This is shown as a yes (Y) or no (N) comment within the table.

Table 6 lists the mean and maximum TSP, Na and SO_4 concentrations at the four Repap sites as well as three sites in the Winnipeg area which were sampled during the same period (TSP and SO_4 only). This same data is also shown in Figure 2.

TABLE 1 REPAP NORTH LOCATION

Date Sampled	Wind Direction (degrees)	Wind Speed (kph)	Particulate Conc (µg/m³)	Sodium Conc (µg/m³)	Sulphate Conc (µg/m³)	Winds from Source
12/20/90	WNW	8.5	3	ND	3.53	N
12/22/90	SSW	3.5	15	ND	5.54	Y
12/29/90	W	17.7	4	ND	4.11	N
01/05/91	W-NW	CALM	3	ND	4.11	N
01/09/91	W-SW	2-5	6	ND	5.76	N
01/12/91		EQUIPMENT MALFUNCTION				
01/15/91		EQUIPMENT MALFUNCTION				
01/19/91	N-NW	10-52	8	0.82	7.05	N
01/26/91	W-NNW	28-50	5	0.83	6.33	N
02/02/91		EQUIPMENT MALFUNCTION				
02/07/91	SW	10	1	ND	1.57	N
02/09/91	NW	26	8	0.11	6.01	N
02/12/91	E	7	6	3.50	6.68	N
02/15/91	WSW	9.8	5	2.60	4.96	N
02/19/91	SSE	17.3	6	1.78	6.35	Y
02/22/91	NW	13.7	5	ND	5.38	N
02/26/91	NNW	3.5	6	ND	5.37	N
02/28/91	W	9.0	5	ND	5.40	N
03/02/91	N	6.5	1	ND	4.68	N
03/05/91	NW	23.0	4	ND	8.12	N
03/08/91	E	12.2	4	ND	5.92	N
03/12/91	SE	15.8	11	1.67	13.13	Y
03/15/91	SSE	14.2	13	2.01	7.32	Y
03/20/91	ESE	10	5	3.83	2.40	N
03/23/91	N	20.8	6	5.15	3.71	N
03/27/91	NW	24.6	5	1.39	2.70	N

ND - NON DETECTABLE

TABLE 2 REPAP EAST LOCATION

Date Sampled	Wind Direction (degrees)	Wind Speed (kph)	Particulate Conc ($\mu g/m^3$)	Sodium Conc ($\mu g/m^3$)	Sulphate Conc ($\mu g/m^3$)	Winds from Source
12/20/90		EQUIPMENT MALFUNCTION				
12/22/90	SSW	3.5	11	ND	3.34	N
12/29/90	W	17.7	8	ND	4.90	Y
01/05/91	W-NW	CALM	15	ND	5.88	Y
01/09/91	W-SW	2-5	13	0.37	4.09	Y
01/12/91	ESE	3-8	14	1.76	8.80	N
01/15/91	W	4-6	6	0.21	5.33	Y
01/19/91	N-NW	10-52	12	1.37	7.24	Y
01/26/91	W-NNW	28-50	4	0.05	5.49	Y
02/02/91	SW	8-10	2	4.38	2.29	N
02/07/91	SW	10	3	ND	1.34	N
02/09/91	NW	26	13	4.51	5.07	Y
02/12/91	E	7	14	ND	6.43	N
02/15/91	WSW	9.8	4	2.97	3.15	Y
02/19/91	SSE	17.3	3	ND	3.08	N
02/22/91	NW	13.7	41	2.75	14.14	Y
02/26/91	NNW	3.5	11	0.10	4.72	Y
02/28/91	W	9.0	10	ND	4.79	Y
03/02/91	N	6.5	7	ND	3.15	N
03/05/91	NW	23.0	8	ND	8.10	Y
03/08/91	E	12.2	7	ND	3.73	N
03/12/91	SE	15.8	15	3.77	13.24	N
03/15/91	SSE	14.2	8	ND	5.38	N
03/20/91	ESE	10	7	4.46	2.46	N
03/23/91	N	20.8	9	5.94	3.31	N
03/27/91	NW	24.6	20	ND	2.54	Y

ND - NON DETECTABLE

TABLE 3 REPAP SOUTH LOCATION

Date Sampled	Wind Direction (degrees)	Wind Speed (kph)	Particulate Conc ($\mu g/m^3$)	Sodium Conc ($\mu g/m^3$)	Sulphate Conc ($\mu g/m^3$)	Winds from Source
12/20/90	WNW	8.5	4	ND	1.39	N
12/22/90	SSW	3.5	11	ND	3.52	N
12/29/90	W	17.7	4	ND	3.88	N
01/05/91	W-NW	CALM	5	ND	3.65	N
01/09/91	W-SW	2-5	18	ND	4.02	N
01/12/91	ESE	3-8	12	2.04	9.23	N
01/15/91	W	4-6	5	ND	4.70	N
01/19/91	N-NW	10-52	46	10.60	32.51	Y
01/26/91	EQUIPMENT MALFUNCTION					
02/02/91	SW	8-10	4	ND	3.32	N
02/07/91	SW	10	6	ND	1.76	N
02/09/91	NW	26	22	4.57	7.39	Y
02/12/91	E	7	10	2.84	5.87	N
02/15/91	WSW	9.8	19	ND	3.78	N
02/19/91	SSE	17.3	15	0.59	3.76	N
02/22/91	EQUIPMENT MALFUNCTION					
02/26/91	EQUIPMENT MALFUNCTION					
02/28/91	EQUIPMENT MALFUNCTION					
03/02/91	N	6.5	28	2.09	5.38	Y
03/05/91	NW	23	26	ND	12.95	Y
03/08/91	E	12.2	38	1.16	4.27	N
03/12/91	SE	15.8	12	0.78	11.85	N
03/15/91	SSE	14.2	9	2.57	7.66	N
03/20/91	ESE	10	4	2.47	2.60	N
03/23/91	N	20.8	10	0.12	3.58	Y
03/27/91	NW	24.6	26	3.88	3.03	Y

ND - NON DETECTABLE

TABLE 4 REPAP WEST LOCATION

Date Sampled	Wind Direction (degrees)	Wind Speed (kph)	Particulate Conc ($\mu g/m^3$)	Sodium Conc ($\mu g/m^3$)	Sulphate Conc ($\mu g/m^3$)	Winds from Source
12/20/90	WNW	8.5	5	ND	2.32	N
12/22/90		EQUIPMENT MALFUNCTION				
12/29/90		EQUIPMENT MALFUNCTION				
01/05/91		EQUIPMENT MALFUNCTION				
01/09/91		EQUIPMENT MALFUNCTION				
01/12/91		EQUIPMENT MALFUNCTION				
01/15/91		EQUIPMENT MALFUNCTION				
01/19/91	N-NW	10-52	5	0.56	7.59	N
01/26/91	W-NNW	28-50	7	1.76	6.23	N
02/02/91		EQUIPMENT MALFUNCTION				
02/07/91		EQUIPMENT MALFUNCTION				
02/09/91	NW	26	16	2.09	5.30	N
02/12/91	E	7	60	1.19	6.91	N
02/15/91	WSW	9.8	31	0.83	4.47	N
02/19/91	SSE	17.3	27	ND	4.27	N
02/22/91	NW	13.7	27	2.48	12.74	N
02/26/91	NNW	3.5	27	3.60	11.39	N
02/28/91	W	9.0	10	ND	5.05	N
03/02/91	N	6.5	23	ND	3.53	Y
03/05/91	NW	23	10	ND	9.09	N
03/08/91	E	12.2	16	ND	4.13	N
03/12/91	SE	15.8	9	1.18	8.78	N
03/15/91	SSE	14.2	48	0.42	4.99	N
03/20/91	ESE	10	50	ND	2.09	N
03/23/91	N	20.8	78	5.04	4.23	Y
03/27/91	NW	24.6	75	5.21	3.51	N

ND - NON DETECTABLE

TABLE 5 HIGHEST TEN VALUES (ALL STATIONS)

	TSP			Na			SO_4		
Rank	Date	Conc	Wind Assoc.	Date	Conc	Wind Assoc.	Date	Conc	Wind Assoc.
1	03/23/91	78	Y	01/19/91	10.6	Y	01/19/91	33.5	Y
2	03/15/91	75	N	03/23/91	5.9	N	02/22/91	14.1	Y
3	02/12/91	60	N	03/27/91	5.2	N	03/12/91	13.2	N
4	03/20/91	50	N	03/23/91	5.2	N	03/12/91	13.1	Y
5	03/15/91	48	N	03/23/91	5.0	Y	03/05/91	13.0	Y
6	01/19/91	46	Y	02/09/91	4.6	Y	02/22/91	12.7	N
7	02/22/91	41	Y	02/09/91	4.5	Y	03/12/91	11.9	N
8	03/08/91	38	N	03/20/91	4.5	N	02/26/91	11.4	N
9	02/15/91	31	N	02/02/91	4.4	N	01/12/91	9.2	N
10	03/02/91	28	Y	03/27/91	3.9	Y	03/05/91	9.1	N

All concentrations are expressed in units of micrograms per cubic metre (ug/m^3) of air.

TABLE 6 COMPARISON OF THE PAS AND WINNIPEG AIR QUALITY
(December 1990 - March 1991)

Location	Parameter	No. of Results	Mean Value	Maximum Level
Repap North	TSP	23	6	15
	SO4	23	5.48	13.13
	Na	23	1.03	5.15
Repap East	TSP	25	11	41
	SO4	25	5.28	14.14
	Na	25	1.31	5.94
Repap South	TSP	22	15	46
	SO4	22	6.37	32.51
	Na	22	1.53	10.60
Repap West	TSP	18	29	78
	SO4	18	5.92	12.74
	Na	18	1.35	5.21
Winnipeg Downtown	TSP	15	54	200
	SO4	15	3.03	8.17
Winnipeg Residential	TSP	15	24	60
	SO4	15	2.56	7.97
St. Francois Xavier	TSP	13	12	24
	SO4	13	2.21	6.85

All concentrations levels are expressed in micrograms per cubic metre ($\mu g/m^3$) of air.

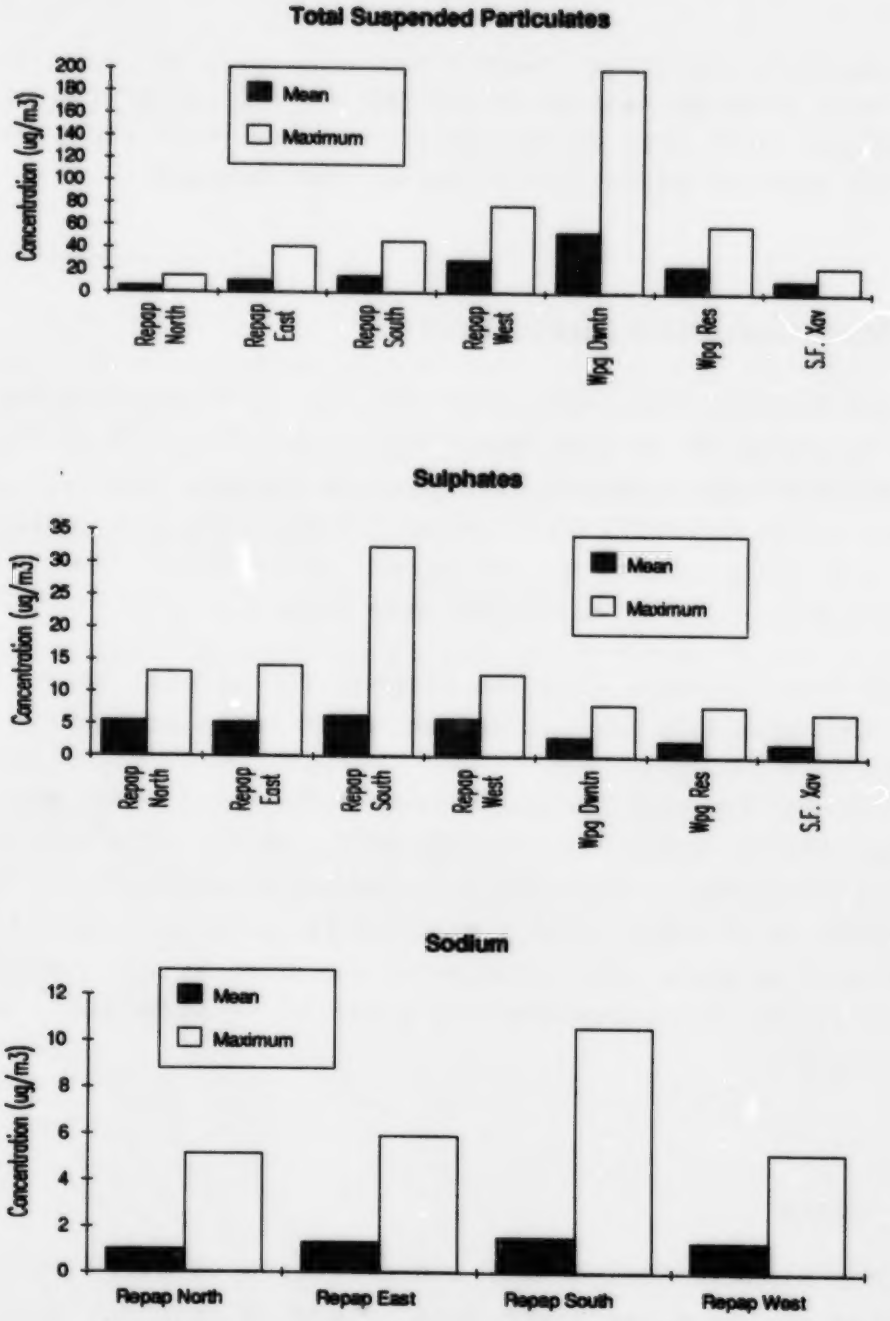

Figure 2 - Comparison of Concentrations Between The Pas Locations and other Manitoba Sites

DISCUSSION

There were 88 samples collected during the course of this study, with only 25 of these occurring when winds were from the general direction of Repap (±45 degrees).

Total Suspended Particulate

The highest TSP level measured was 78 micrograms per cubic metre ($\mu g/m^3$) at the Repap West station; winds on this day were from the general direction of Repap. This concentration is still well below the Manitoba Air Quality Objective (MAQO) level of 120 $\mu g/m^3$. The highest mean value was 29 $\mu g/m^3$, also at the Repap West site.

Of the ten days with the highest TSP levels, only four had winds from the general direction of Repap (Table 5).

During the same period of time a Winnipeg downtown station (9119) had a maximum TSP level of 200 $\mu g/m^3$ and a mean of 54 $\mu g/m^3$, a Winnipeg residential station (9118) had a maximum of 60 $\mu g/m^3$ with a mean of 24 $\mu g/m^3$, and a rural background station just outside of Winnipeg at St. Francois Xavier (4304) had a maximum TSP level of 24 $\mu g/m^3$ and a mean of 12 $\mu g/m^3$.

Sodium

The highest Sodium (Na) concentration of 10.60 $\mu g/m^3$ occurred at the Repap South site; winds on this day were from the general direction of Repap and this was one of the few days where Na levels were higher than blank concentrations. There are no Manitoba Guidelines or Objectives for Sodium. The highest mean Na concentration

was 1.53 µg/m³ at the Repap South site.

Of the ten days with the highest Na levels five had winds from the general direction of Repap (Table 5).

Sulphate

The highest SO_4 concentration of 32.51 µg/m³ occurred at the Repap South station on the same day as the highest Sodium level while winds were from the general direction of Repap. There are no Manitoba Guidelines or Objectives for Sulphate. The highest mean SO_4 concentration was 6.37 µg/m³ at the Repap South site.

Of the ten days with the highest SO_4 levels only four had winds from the general direction of Repap (Table 5).

During the same period of time a Winnipeg downtown station (9119) had a maximum SO_4 concentration of 8.17 µg/m³ with a mean of 3.03 µg/m³, a Winnipeg residential site (9118) had a maximum of 7.97 µg/m³ with a mean of 2.56 µg/m³ and a rural background station (4304) had a maximum SO_4 level of 6.85 µg/m³ and a mean of 2.21 µg/m³.

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